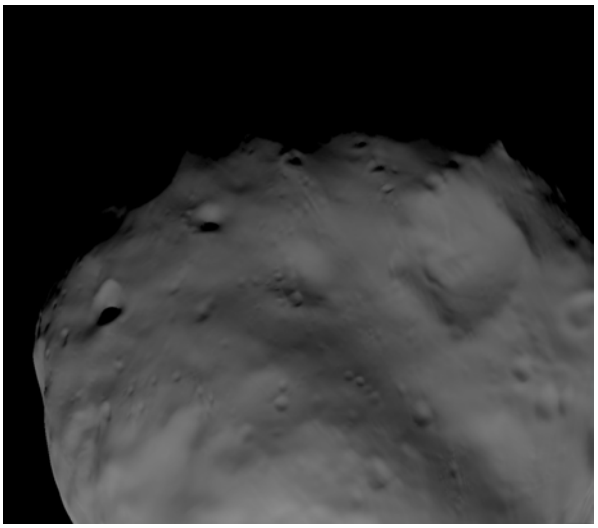
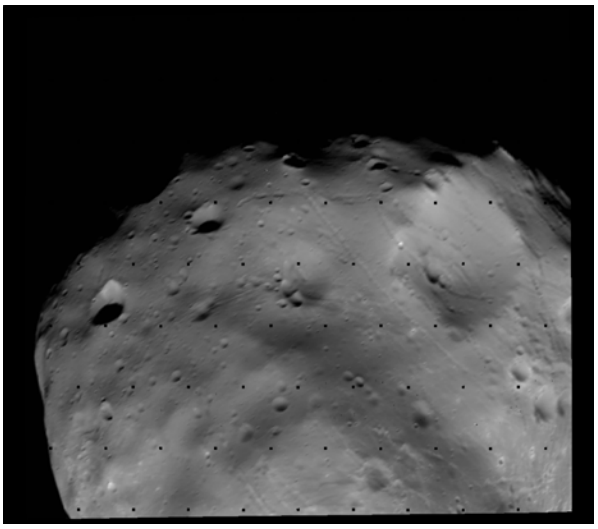
OPTICAL-ONLY DETERMINATION OF SMALL BODY SHAPE AND TOPOGRAPHY. R.W. Gaskell, JPL/Caltech, MS 301/150, 4800 Oak Grove Drive, Pasadena, CA 91109, (818) 354-2116, rwg@piglet.jpl.nasa.gov.

Introduction: A combination of three types of optical data, stereography, limb alignment, and multiple image photoclinometry, is being used to construct high resolution shape and topography models of small bodies. This approach is capable of producing topographic models at the same resolution as the available imagery for use in navigation and shape characterization during orbital missions. The approach is equally effective for mapping airless planetary bodies or large asteroids, since the limbs and obliquely viewed landmarks are not degraded by an atmosphere.

Phobos Model: As an example, a 1.57 million vector model of Phobos has been constructed using Viking Orbiter and Phobos '88 images. An image of the model is shown below, along with the corresponding Viking Orbiter image (315A11).





Nearly two hundred overlapping landmark maps, each containing 10,000 surface vectors, were averaged to produce a low resolution (25,000 vector) shape model. The volume of Phobos determined from this model was about 5755 km^3, while the principal moments per unit mass are 43.8 km^2, 51.4 km^2, and 60.2 km^2. A more detailed model was then constructed by integrating the averaged map gradients relative to the low resolution model.

Template Construction The landmark templates are constructed as part of a three-step cyclical iteration with each step supplying refined inputs for the next:

1. Images are registered (aligned), the central landmark vectors determined, and possibly the spacecraft vectors found, by minimizing the weighted mean square residuals between nominal and observed landmark locations, limbs, and overlapping landmark templates.
2. The surface gradient and albedo at each pixelized location within the landmark are determined by minimizing the mean square residuals between the re-illuminated model and imaging data extracted from a number of pictures.
3. The gradients are integrated to produce the height distribution in the landmark, with limb points and sparsely sampled heights from overlapping maps included to provide an absolute height scale, and to prevent errors in the gradient solutions from propagating too far.

References

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